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DRAWINGS ATTACHED

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(54) PRINTED CIRCUITS AND METHOD OF MANUFACTURE

(71) We, WESTINGHOUSE ELECTRIC CORPORATION of 3 Gateway Center, Pittsburgh, Pennsylvania, United States of America, a company organised and existing under the laws of the Commonwealth of Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to printed circuits and methods of preparation suitable for printed circuit applications and more particularly to such circuits wherein electrical interconnection is provided through the circuit board.

Terminal boards, as presently used in printed circuitry frequently require that a connection must go through the board rather than around the edge and this type of connection is normally referred to as a "through connection" or a "through-hole connection". There are several different techniques for accomplishing this electrical connection. This invention is directed to what is known in the art as the plated-through-hole process. This process starts with a plain insulating substrate in which the necessary holes are drilled or punched. The surface of the board including the walls of the holes is then rendered conductive by depositing by chemical reduction, a conductive coating such as copper. An electroplated coating of suitable conductive material such as copper is then deposited over the board including the walls of the holes and then by suitable techniques known in the art printed circuits are formed on both surfaces of the board and the circuits on opposite surfaces may be interconnected through conductive coating provided through the holes.

The reliability of through connections in printed circuit boards is of primary importance in the case of multilead modules. The connection through the board must be continuous from the solder joint through the board to the circuitry on the opposite side of the board and the connection must withstand the manufacturing processes and environmental exposure in service. It has been found that in the standard processes now known in the industry that the plated through-hole process is a possible source of failure. It has been found that cracks are formed through the conductive coatings in the holes. A study of this cracking was made and it has been found that this cracking occurred during soldering operations made to the printed circuit board. Further investigation indicated that the molten solder was not necessarily the only source of fracture and that simply heating the joint to soldering temperature could result in a cracked coating. The common insulating base material for printed circuit boards is an epoxy resin with glass reinforcement which has a very high thermal expansion in the thickness direction of the printed circuit board. This expansion rate may be as high as ten times that of some type of copper.

Accordingly, it is the primary object of this invention to provide an improved interconnection between opposite surfaces of a terminal board.

With this object in view the present invention resides in a method of manufacturing printed circuit boards in which opposed conductive coatings on a dielectric base are connected through a conductive coated aperture wall, said method comprising the steps of providing a dielectric base having an aperture therein, depositing a first conductive coating on the wall of said aperture to provide a conductive coating for subsequent electroplating coatings, electrodepositing a second coating of conducting material on said first coating and electrodepositing a third coating including copper onto said second coating from a cyanide bath.

The invention fill become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example only, in the accompanying drawings, in which:

Figure 1 is a plan view of a portion of a printed circuit board in accordance with the teaching of this invention;

Fig. 2 is a sectional view taken along the line II—II of Fig. 1;

[Price 25p]

Fig. 3 is an enlarged sectional view of a portion of the printed circuit board of Fig. 1 taken along the line II—II; and

Figs. 4 through 9 inclusive are fragmentary sectional views illustrating certain steps of the method that are successively performed in accordance with the teachings of this invention.

With reference to Figs. 1 and 2, a portion of a printed circuit board 10 is illustrated. The board 10 includes an insulating base member 12 of a suitable material such as epoxy glass. The base member 12 is provided with three openings or holes 14. Each of the holes 14 is provided with a plated-through-hole connection 16. A printed circuit 18 illustrated as a single conductor is provided on the upper surface of the base 12. The circuit 18 connects the connector 16 centrally located and another connector 16 in the left-hand portion of the board 10. A printed circuit 20 illustrated as a single conductor is provided on the lower surface of the base 12. The circuit 20 connects the centrally located connector 16 to a connector 16 located in the right portion of the board 10. The centrally located connector 16 interconnects the two circuits 18 and 20.

An electrical component 22 such as a resistor may be connected to one of the connectors 16. A lead 24 from the component 22 is soldered into the connector 16 and solder material 26 surrounds the lead 24 securing the lead 24 to the connector 16.

The connector 16 is shown in detail in Fig. 3. The inner walls of the hole 14 are provided with an electrically conductive coating 30. The conductive coating 30 may be provided by suitable treatment well known in the art to provide a chemical or electroless deposition to provide a suitable conductive coating for electroplating. The conductive clad base may then be placed in a solution and an electroplating conductive coating 32 is provided over the coating 30. The coating 32 is normally provided from a non-cyanide bath such as copper pyrophosphate. The next conductive coating 34 is also an electroplated coating of a suitable material including copper from a cyanide bath. A coating 36 of a suitable conductive material such as lead-tin is provided by electroplating on the coating 34. This structure provides the interconnection member 16 between the circuit 18 on the upper surface of the base 12 and the circuit 20 on the lower surface of the base 12. The component 22 may be attached to the connector 16 by soldering the lead 24 into a suitable solder solution which solidifies as indicated to form the solder filling 26 in the connector 16.

It has been found as previously indicated that in plated-through-type connectors of the prior art device that the soldering operating results in a break or crack forming through the connector 16 which of course can result in obvious failure on the interconnection member 16 between the upper and lower surface of the printed circuit board. The above structure and method as described below does not suffer from this defect.

Referring now to Figs. 4 through 9, the applicants' invention will be more fully described. The base 12 as illustrated in Fig. 4 is provided of a suitable material such as epoxy glass and the hole 14 is drilled or punched through the base 12 to provide the hole 14 as illustrated in Fig. 4.

The coating 30 is provided by first immersing the base 12 in a suitable aqueous sensitizer solution such as stannous chloride. This step requires about 3 to 10 minutes at room temperature after a suitable water rinse. The base 12 is immersed in a suitable activator solution of palladous chloride at room temperature for about 10 minutes. The base 12 is then rinsed and then immersed in a solution comprising copper sulphate, Rochelle Salt and formaldehyde. This step takes about 30 minutes at room temperature. A suitable solution for copper is found on page 429 of the "Metal Finishing Guidebook Directory" for 1966, published by Metals and Plastics Publications, Inc., Westwood, New Jersey. A suitable process for nickel is found on pages 393 and 394 of the above-mentioned "Metal Finishing Guidebook Directory". Other suitable coating materials are palladium, silver and gold. The coating 30 is of a thickness of about .000005 inch.

The copper clad board 10 as shown in Fig. 5 is then immersed in a suitable non-cyanide bath such as an acid bath of sulfate or fluoroborate. An alkaline bath of pyrophosphate is also suitable. A suitable pyrophosphate bath is found on page 229 of the above-mentioned handbook. The bath comprises copper pyrophosphate, potassium pyrophosphate and ammonia. Suitable acid baths are found on pages 213 to 218. The electroplated coating 32 is made to a thickness of .0003 to .0008 inch. This structure is shown in Fig. 6.

The next step in the operation as indicated in Fig. 7 is the application of the electroplating coating 34 of copper which as the other coatings 30 and 32 covers both surfaces of the base 12 and the walls of the hole 14. This electroplating bath is a cyanide solution such as described on page 24 of the above-mentioned handbook. A suitable solution may be 6.5 to 9.0 oz./gal. of copper cyanide, 1.8 to 2.5 oz./gal. of free potassium cyanide, 2.0 to 3.0 oz./gal. of hydroxide, 1.2 oz./gal. of potassium carbonate with suitable additives. The coating 34 is made to a thickness of about .001 inch in the hole. The coating 34 is found to be a very ductile deposit.

The next step in the operation is the application of photoresist in a manner well known in the art to provide a coating 38 on selected portions of the coating 34 as illustrated in Fig. 8. A lead-tin coating 36 as illustrated in Fig. 8 is then applied by electroplating process, the coating 36 facilitating soldering of compo-

nents. A suitable bath is described on pages 251 through 253 of the above-mentioned Handbook to provide a coating 36 of about 40% lead and 60% tin. The coating 36 has a thickness of about .0003 inch. This structure is illustrated in Fig. 8.

The next step is to remove the resist coating 38 and then etch away the coatings 30, 32 and 34 beneath the coating 38 to provide the structure shown in Fig. 9. This completes the printed circuit board and the board is now ready for assembly of components such as 22 to the board. A suitable solder may be utilized as shown in Fig. 3 as item 26 to secure the lead 24 within the connector 16.

WHAT WE CLAIM IS:—

1. A method of manufacturing printed circuit boards in which opposed conductive coatings on a dielectric base are connected through a conductive coated aperture wall, said method comprising the steps of providing a dielectric base having an aperture therein, depositing a first conductive coating on the wall of said aperture to provide a conductive coating for subsequent electroplating coatings, electrodepositing a second coating of conductive material on said first coating and electrodepositing a third coating including copper onto said second coating from a cyanide bath.

2. A method as claimed in claim 1, wherein the first conductive coating is provided by sensitizing the surface with a chemical deposit to accommodate a subsequent conductive deposit by chemical reduction of materials selected from the group consisting of copper, nickel, palladium, silver and gold.

3. A method as claimed in claim 1 or 2, wherein the second coating is deposited from a bath selected from the group consisting of sulfuric acid, fluoroborate acid or pyrophosphate.

4. A method as claimed in claim 1, 2 or 3, wherein the third coating is deposited from a cyanide bath comprising water, copper cyanide, potassium cyanide, potassium hydroxide and potassium carbonate.

5. A printed circuit board comprising a deielectric base member, an electroplated through-connector extending through an aperture in said base member, said connector comprising a chemically deposited coating of copper on the walls of said aperture, a non-cyanide electroplated coating of copper on said chemical coating, and a cyanide electroplated coating including copper deposited on said non-cyanide coating.

6. A method of manufacturing printed circuit boards, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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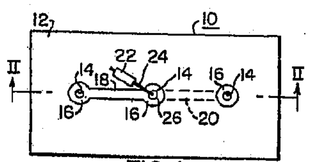

FIG. 1.

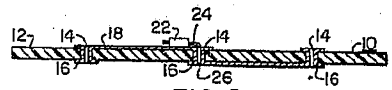

FIG. 2.

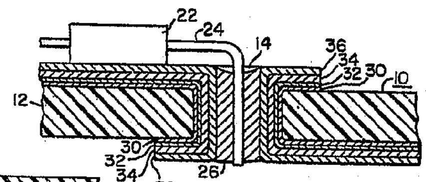

FIG. 3.

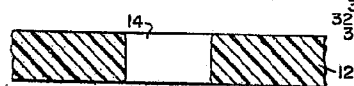

FIG. 4.

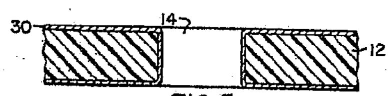

FIG. 5.

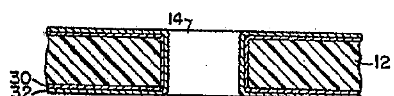

FIG. 6.

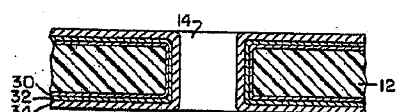

FIG. 7.

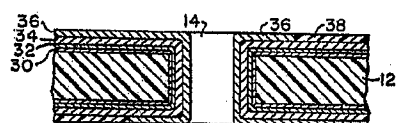

FIG. 8.

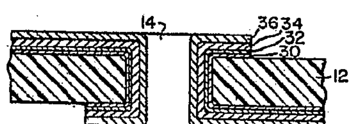

FIG. 9.